

Prompt and Precise Prototyping

For Sanders Design International, Inc., of Wilton, New Hampshire, every passing second between the concept and realization of a product is essential to succeed in the rapid prototyping industry—where amongst heavy competition, faster time-to-market means more business.

To separate itself from its rivals, Sanders Design aligned with NASA's Marshall Space Flight Center to develop what it considers to be the most accurate rapid prototyping machine for fabrication of extremely precise tooling prototypes. The company's Rapid ToolMaker™ System has revolutionized production of high quality, small-to-medium sized prototype patterns and tooling molds with an exactness that surpasses that of computer-numerically-controlled (CNC) machining devices.

Created with funding and support from Marshall under a **Small Business Innovation Research (SBIR)** contract, the Rapid ToolMaker is a dual-use technology with applications in both commercial and military aerospace fields. The advanced technology provides cost savings in the design and manufacturing of automotive, electronic, and medical parts, as well as in other areas of consumer interest, such as jewelry and toys. For aerospace applications, the Rapid ToolMaker enables fabrication of high-quality turbine and compressor blades for jet engines on unmanned air vehicles, aircraft, and missiles.

The Rapid ToolMaker can generate numerous compound surface features not possible with CNC machines. For example, it can easily produce complex turbine-bladed disk (blisk) patterns, comprised of the hub, blades, and outer retaining rims, as a single unit. It can also construct miniature air passages as small as 75 microns to facilitate air cooling of critical airfoil surfaces, with entrance and exit ports near or on the leading and trailing edges of the blades, respectively. These patterns undergo direct investment casting to yield composite metal turbine blades. Patterns fabricated on the Rapid ToolMaker enable future availability of replacement patterns for manufacturing operations, as well as long-term logistic and maintenance support.

Designed for unattended operation, the Rapid ToolMaker is a freestanding unit that supports a computer-aided design (CAD) workstation environment. It sequentially builds one layer at a time from a stereolithography file or a Hewlett-Packard Graphic Language file; Microsoft® Windows®-based graphical user interface software provides direct use and editing of various other CAD file formats.

The system's ink-jet deposition process for layered fabrication of 3-dimensional prototypes improves accuracy and surface finish quality by a factor of 10,

compared with other rapid prototyping technologies, according to Sanders Design. A combination of build and support material is deposited as low-viscosity "ink" by dual ink-jets, which glide over a build platform on a precision, computer-driven carriage. This technique ensures layer uniformity, registration, and exact replication of a CAD design file. A solvent then removes the sacrificial support material without additional post-processing. The completed prototype pattern is dimensionally accurate with a smooth surface finish, and is used directly for metal casting or mold forming.

The technology has several automated features that ensure proper model construction and quality. Print head operation is checked under program control by moving the print head assembly to a validation station to monitor proper material flow. Heated material reservoirs hold the material for 100 hours of continuous operation, and replenishment does not interrupt a job in process. Additionally, a controller monitors and directs all operations under software control for the entire length of the fabrication.



According to Sanders Design International, Inc., the Rapid ToolMaker™ is the most accurate free-form fabrication system in the world. It enables rapid prototyping of precision tooling patterns for aerospace, medical, electronic, automotive, and consumer products direct from computer-aided design files using layered fabrication techniques and ink-jet deposition technology.



Bladed disks (blisks) and turbine blades for small- to full-scale jet engines are produced by the Rapid ToolMaker™ system with unsurpassed fidelity, precision, accuracy, detail, surface finish, and repeatability for missile and commercial airliner applications. Using a sacrificial and dissolvable support material, the RTM can repeatably produce any blisk design which cannot be fabricated using traditional prototyping, computer-numerically-controlled devices, or other special tooling methods.

The Rapid ToolMaker's accolades include being named the grand winner at the 1997 NASA-sponsored "Technology 2007" Conference in Boston, Massachusetts, and winning the SBIR "Technology of the Year" Award from the Technology Utilization Foundation in the same year.

Sanders Design is currently participating in Phase II of a separate SBIR contract with NASA's Langley Research Center to enhance the Rapid ToolMaker. The goal of this partnership is to fabricate ceramic

models with self-contained sensor conductors simultaneously in a single unit, for wind tunnel testing that could potentially lead to advanced Space Shuttle design. Direct fabrication of ceramic parts has multiple benefits for producing low-cost precision devices that can withstand extremely harsh environments encountered in automotive and aerospace applications.

Rapid ToolMaker™ is a trademark of Sanders Design International, Inc. Microsoft® and Windows® are registered trademarks of Microsoft Corporation.



The Rapid ToolMaker's™ ability to position ink-jet droplets to within ±5 microns enables fine-featured jewelry and other prototypes to be fabricated in a flawless manner. This diamond-studded earring prototype is shown expanded six times through a jeweler's eye loupe.